Potential Risks to Infants from Breastfeeding

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Overview

- **Potential risks from consumption of breast milk**
  - EPA/DEQ risk assessment approach
- **Balancing risks and benefits from breastfeeding**
  - Public health perspective and recommendations

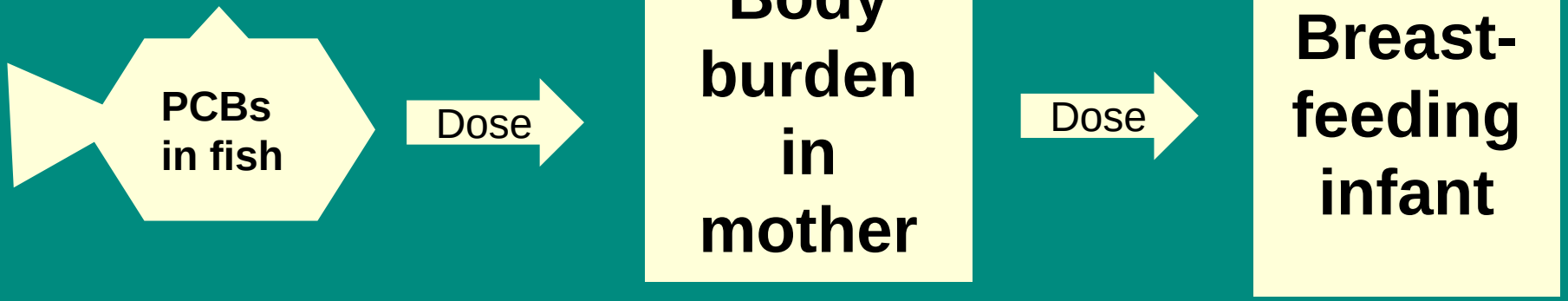
Introduction

- Portland Harbor Federal Superfund Site
- Various exposure pathways, including fish consumption
- Breastfeeding suggested as a potential exposure pathway years ago

Risk Calculations

- Equations taken from EPA RA guidance for combustion facilities (Sept 2005)
- Apply some reasonable assumptions
- Use PCBs as an example

Conceptual Model



Dose to Mother

$$ADD_{mother} = \frac{C_{fish} \times IR_{fish} \times CF \times F_{fish}}{BW_{af}}$$

Where:

- ADD_{mother} = Average daily dose to mother (mg/kg/day)
- C_{fish} = Chemical conc in fish (assume 1 mg/kg)
- IR_{fish} = Ingest rate of fish (subsist rate of 142 g/day)
- CF = Conversion factor (0.001 kg/g)
- F_{fish} = Fraction of fish contaminated (1)
- BW_{af} = Body weight (66 kg for average adult female)

Dose to Mother

ADD_{mother} =

= 1 mg/kg x 142 g/day x 0.001 kg/g x 1 / 66 kg

= 0.0022 mg/kg/day

Concentration in Milkfat

$$C_{milkfat} = \frac{ADD_{mother} \times h \times f1}{\ln(2) \times f2}$$

Where:

$C_{milkfat}$	=	PCB concentration in milkfat (mg/kg-lipid)
ADD_{mother}	=	Average daily dose to mother (mg/kg/day)
h	=	Half-life of PCB (7 years = 2555 days)
f1	=	Fraction of ingested PCB stored in fat (0.9)
f2	=	Fraction of mother's weight that is fat (0.3 kg-lipidBW/kg-totalBW)

Concentration in Milkfat

$$C_{milkfat} =$$

$$= \frac{0.0022 \text{ mg/kg-totalBW/day} \times 2555 \text{ days} \times 0.9}{0.693 \times 0.3 \text{ (kg-lipidBW/kg-totalBW)}}$$

$$= 24 \text{ mg/kg-lipid}$$

Dose to Infant

$$ADD_{infant} = \frac{C_{milkfat} \times IR_{milk} \times f3 \times f4 \times EDc \times EFc}{ATnc \times BWc}$$

Where:

ADD_{infant}	=	Average daily dose for breastfeeding infant (mg/kg/day)
$C_{milkfat}$	=	Concentration of chemical in milk fat (mg/kg-lipid)
IR_{milk}	=	Ingestion rate of breast milk (0.69 kg-milk/day)
f3	=	Fraction of breast milk that is fat (0.04 kg-lipid/kg-milk)
f4	=	Fraction of ingested PCB that is absorbed (0.9)
EDc	=	Exposure duration of breastfeeding infant (1 year)
EFc	=	Exposure freq of breastfeeding infant (365 days/year)
ATnc	=	Averaging time – non-carcinogen (= EDc x EFc)
BWc	=	Body weight of breastfeeding infant (9.4 kg)

Dose to Infant

$$ADD_{infant} =$$

$$= \frac{24\ mg/kg\text{-}lipid \times 0.69\ kg\text{-}milk/day \times 0.04\ kg\text{-}lipid/kg\text{-}milk \times 0.9 \times 1\ yr \times 365\ day/yr}{1\ yr \times 365\ day/yr \times 9.4\ kg}$$

$$= 0.063\ mg/kg/day$$

Relative Dose to Infant

- ADDmother = 0.0022 mg/kg/day
- ADDinfant = 0.063 mg/kg/day

- Subchronic dose to infant is almost 30 times chronic dose to mother
- Independent of exposure route

Calculated Noncancer Risk

$$HQ_{infant} = \frac{ADD_{infant}}{RfD}$$

Where:

HQ_{infant} = Hazard quotient for breastfeeding infant

RfD = Non-cancer reference dose (intermediate-duration MRL = 3×10^{-5} mg/kg/day for total PCBs)

HQ_{infant} = 0.063 mg/kg/day / 0.00003 mg/kg/day = 2,100

Relative Risk to Infant

- HQ-mother = 110
- HQ-infant = 2,100

- HQ to infant is 20 times HQ to mother

Calculated Cancer Risk

$$ELCR_{child} = ADD_{child} \times SFo$$

Where:

$ELCR_{child}$ = Excess lifetime cancer risk to child from breastfeeding

SFo = Oral cancer slope factor 2 $(mg/kg/day)^{-1}$ for total PCBs

$ELCR_{child}$ = 0.00091 mg/kg/day x 2 $(mg/kg/day)^{-1}$

= 2×10^{-3}

Uncertainty

- **Intermediate-duration MRL**
  - Based on exposure to infant monkeys
  - Matched human breast milk congener mix
  - LOAEL 0.0075 mg/kg/day / 300 UF = 0.00003 mg/kg/day
- **Considered using chronic RfD**
  - Monkey LOAEL 0.005 mg/kg/day / 300 UF = 0.00002 mg/kg/day
  - One year exposure (not lifetime)
- **Confounding effects of prenatal exposure**

Uncertainty

- **Exposure duration of mother**
  Dose to infant reduced by half if ED = 7 years
- **Body burden reduction**
  480 mg / 2 = 240 mg
- **Variation in infant ingestion rate and body weight**
- **Risk contribution from other chemicals (DDT, dioxins, etc.)**

Results Summary

- Dose to infant is almost 30 times dose to mother for chemicals with long half-lives (*e.g.*, PCBs, dioxins)
- HQ for infant is 20 times HQ for mother for PCBs
- Above results do not depend on exposure scenario or dose level

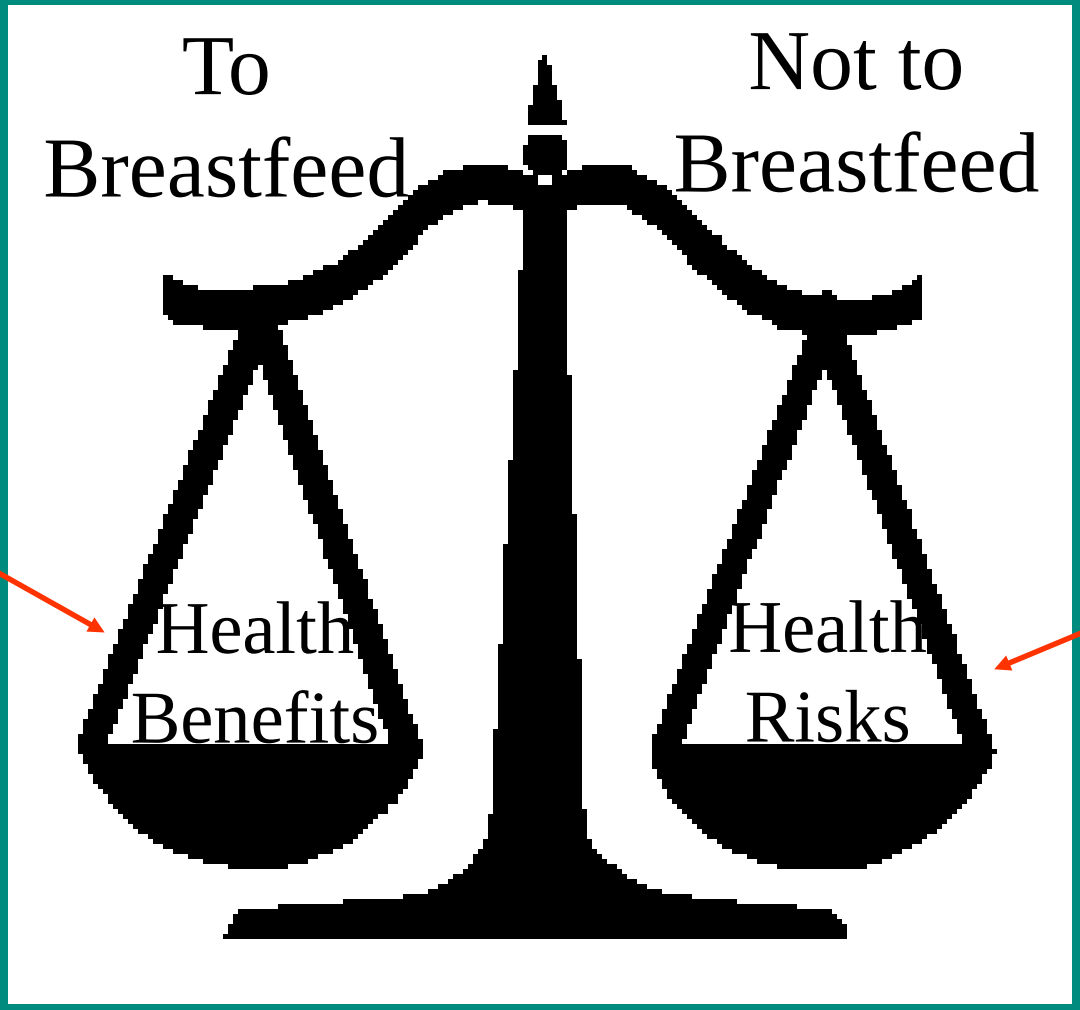
DEQ Conclusions

- We have risk assessment tools to evaluate risks by breast feeding route
- There are potentially significant risks to breast feeding infants of high fish consumption mothers
- ***But***, public health departments tell us that breast feeding is good for you

Oregon Public Health Division's Perspective

- **Balancing calculated risks with measured benefits**
- **Big Questions:**
  - What do we tell nursing women who eat fish from Portland Harbor to do?
  - What should be the focus of Public Health action?

No Accepted Threshold Value for Contaminants in Breast Milk



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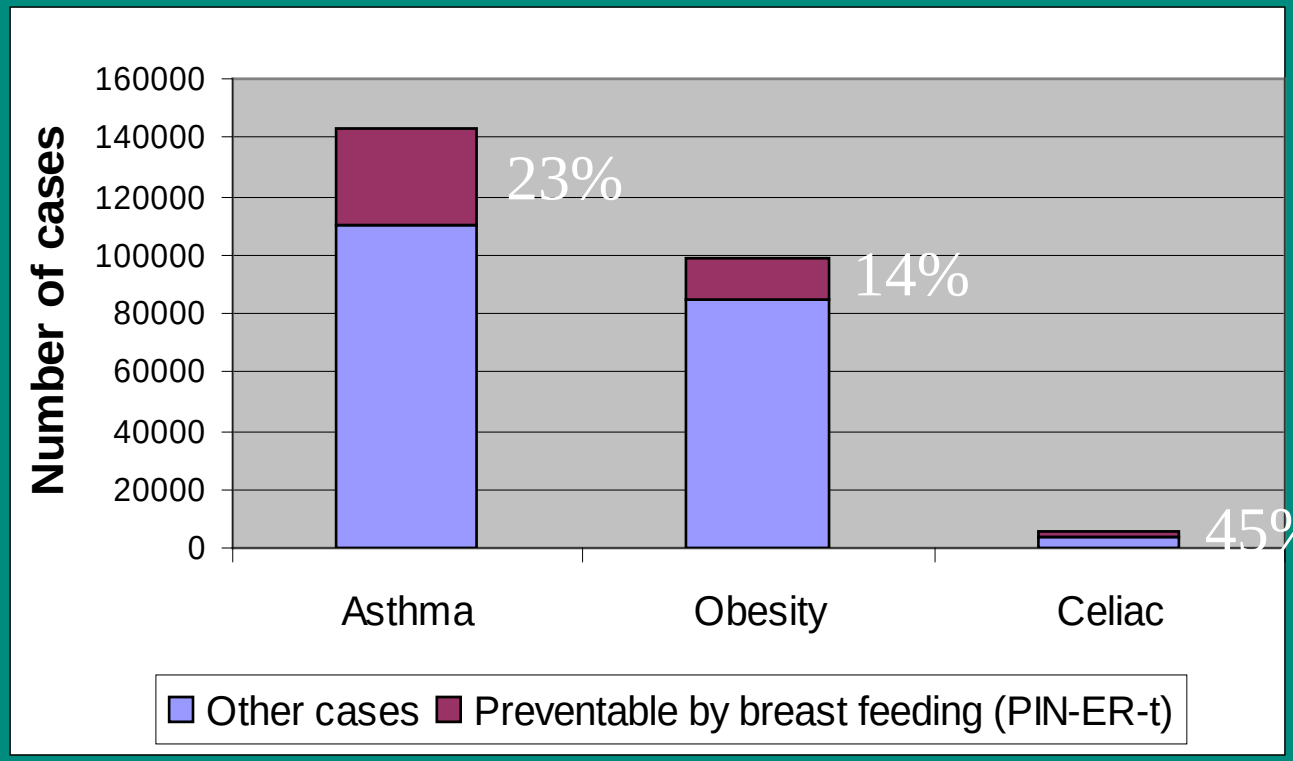
Different and varied quantification methods

Well established approaches to risk quantification

New Method to Quantify Benefits



Adapted from Akobeng et al. 2007

PIN-ER-t = Population Impact Number of Eliminating a Risk Factor Over a Time Period

Breastfeeding is Healthy

- Boosts immune function
- Reduces risk of several chronic health conditions
- Improved IQ and neurocognitive function
- Perfectly balanced and inexpensive nutrition
- Non-breastfed infants have a 21% higher mortality rate

Breastfeeding is Also Healthy for the Mother

- Enhanced psychological well-being (mother and child) and increased bonding between mother and child
- Reduced postpartum bleeding
- Reduced risk of breast and ovarian cancer
- Easier loss of excess adipose accumulated during pregnancy

Calculated PCB Dose in Context of Measured PCBs in Breast Milk

- Measured breast milk PCBs world-wide range from 0.16 – 4 mg/kg-lipid with some as high as 15 mg/kg-lipid
- No actual breast milk measurements as high as the calculated 24 mg/kg-lipid for PH

Calculated Dose in Context of Background and Health Effects

- **Negative correlation between breast milk PCB levels and health of offspring:**
  - Deficit in composite activity rating
  - Deficits in standardized neurocognitive tests
- **In most cases, children with deficits caught up with peers in early childhood**
- **In all cases where comparison was made, breastfed children (even with increased PCBs) still did better than formula-fed children.**
  - However, this finding may be confounded by SES

Message from Oregon DHS

- **Oregon DHS concluded that:**
  - In the absence of individual breast milk PCB measurements, the best option is to continue promoting breastfeeding as the healthiest option for infants
  - Public health message should focus on encouraging compliance with fish advisories already in place for Portland Harbor

Current Fish Advisory for Portland Harbor

Current Fish Advisory for Portland Harbor

- **Women of childbearing age, particularly pregnant or breastfeeding women, children and people with weak immune systems, thyroid or liver problems, should avoid eating resident fish from Portland Harbor, especially carp, bass and catfish.**

What is the Appropriate Public Health Action to Take?

- Considerable resources needed to get the fish advisory info to the right people
- Public outreach and education about fish advisory should be considered part of remedy for sites like Portland Harbor

Conclusions

- We have risk assessment tools to evaluate risks by breastfeeding route
- We have fewer tools to quantify the health benefits of breastfeeding
- There are potentially significant risks to breastfeeding infants of high fish consumption mothers

Conclusions

- Existing literature suggests that promotion of breast feeding is still best course
- Fish advisory promotion and community outreach should be part of site remedy
- EPA and DEQ risk assessors and Oregon Public Health recommend including the breast feeding pathway in baseline risk assessments.
- Comments/suggestions/questions?

Provide Comments/ Suggestions/Questions to:

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